APPARATUS AND METHOD FOR COMPUTER SCREEN SECURITY

FIELD OF THE INVENTION

The present invention is directed to an apparatus and method of preventing unauthorized users from viewing a computer screen.

BACKGROUND

The use of laptop computers in public spaces such as airports, airplanes, and hotel lobbies raises security implications regarding unauthorized viewing by individuals who may be able to see the screen. Additionally, tracking the release of sensitive information can be difficult since unauthorized viewers do not get direct access to the information through a computer and thus do not leave a digital fingerprint from which they could later be identified. Thus, a need exists for an apparatus and method for providing security on computer screens.

Video and image scrambling is a common topic in the prior art (See e.g. U.S. Patent 5,841,863 and U.S. Patent 5,161,188). However, the prior art focuses on the need for scrambling video images at a source, transmitting the scrambled image over various means, and then unscrambling the image at the destination. This method of scrambling and unscrambling is useful for data transmission, however it does not prevent an unauthorized user from viewing the unscrambled image at the destination. What is needed beyond the prior art is an apparatus and method for scrambling a computer screen that will allow the image to be viewed by the authorized user, but will render the computer screen unreadable to unauthorized users.

U.S. Patent 5,863,075 (Rich) discloses an apparatus and method for scrambling and unscrambling images using a plurality of scrambling and unscrambling screens. The intended

image is printed on one screen and can be combined with a seemingly random assortment of other lines and shapes. An unscrambling screen in used to filter out the additional lines and shapes so that the combination of the screens reveals the intended image. However, Rich is limited in that the unscrambling screen must be placed directly upon the scrambled image to view the image. In addition, once the image is unscrambled, the image can be viewed by anyone within the vicinity of the image. What is needed beyond Rich is an apparatus and method for scrambling and unscrambling images in which only the intended viewer is able to view the image.

Therefore, a need exists for an apparatus and a method of preventing casual onlookers from obtaining information on a computer screen. A need also exists for an apparatus and a method of providing additional security for computers by encrypting the computer screen in a way that it is only viewable by a single individual.

SUMMARY OF THE INVENTION

The present invention meets the needs stated above by utilizing a combination of software and hardware that renders the computer screen incomprehensible to onlookers. The software consists of a computer program that scrambles the organization of the image on the computer screen. The scrambling program can start automatically during the computer boot up and the computer display will only show the scrambled information. The hardware consists of a set of glasses that reorganizes the scrambled image on the computer screen so that the authorized user can comprehend the image. The glasses contain lenses consisting of a unique arrangement of smaller square lenses tiled together to form a full size eyeglass lens. The smaller lenses correspond to the break-up pattern used by the software to scramble the computer screen. When

the invention is utilized, the screen is incomprehensible to the normal viewer. However, a viewer equipped with the correct glasses will see the unscrambled image. Another feature of the present invention occurs when the computer is stolen by an unauthorized person who does not have access to the appropriate glasses. In this case, an attempt to view the information on the computer by the unauthorized user would be unsuccessful because the display image is scrambled at the software level. In an alternate embodiment, the scrambled image is transmitted by cable or wireless transmission to a set of display glasses with an embedded personal display computer that unscrambles the image for viewing at the display glasses.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is depiction of a distributed data processing system;

Figure 2 is a depiction of a server computer;

Figure 3 is a depiction of a client computer;

Figure 4A is a depiction of a desktop computer with external display screen;

Figure 4B is a depiction of a laptop computer with built-in display screen;

Figure 5A is a depiction of N x M array on a computer screen where N = 3 and M = 3;

Figure 5B is a depiction of an N x M array of convex lenses for eyeglasses where N = 3 and M = 3;

Figure 5C is a depiction of a first scrambled image on an 3 X 3 array on a computer screen and the corresponding descrambled image seen through an E X E array of convex lenses;

Figure 5D is a depiction of a second scrambled image on an 3 X 3 array on a computer screen and a the corresponding descrambled image seen through a 3 X 3 array of convex lenses;

Figure 6 is a diagram of the image inversion caused by a convex lens;

Figure 7 is a flow chart for the image scrambling process;

Figure 8A is a flow chart of the image scrambling process when used with codewords and display glasses;

Figure 8B is a depiction of the display glasses and connecting cable configuration;

Figure 8C is a schematic of the personal display computer; and

Figure 9 is a flow chart of the personal display computer program.

DESCIPTION OF PREFERREED EMBODIMENT

Figure 1 depicts a pictorial representation of a distributed data processing system in which the present invention may be implemented and is intended as an example, and not as an architectural limitation, for the processes of the present invention. Distributed data processing system **100** is a network of computers which contains a network **102**, which is the medium used to provide communication links between the various devices and computers connected together within distributed data processing system **100**. Network **102** may include permanent connections, such as wire or fiber optic cables, or temporary connections made through telephone connections. In the depicted example, a server **104** is connected to network **102** along with storage unit **106**. In addition, clients **108, 110,** and **112** also are connected to a network **102.** Clients **108, 110,** and **112** may be, for example, personal computers or network computers.

For purposes of this application, a network computer is any computer, coupled to a network, which receives a program or other application from another computer coupled to the network. In the depicted example, server **104** provides Web based applications to clients **108, 110**, and **112.** Clients **108, 110,** and **112** are clients to server **104**. Distributed data processing system **100** may include additional servers, clients, and other devices not shown. In the depicted

example, distributed data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the TCP/IP suite of protocols to communicate with one another. Distributed data processing system **100** may also be implemented as a number of different types of networks, such as, an intranet, a local area network (LAN), or a wide area network (WAN).

Referring to Figure 2, a block diagram depicts a data processing system, which may be implemented as a server, such as server **104** in Figure 1 in accordance with the present invention. Data processing system **200** may be a symmetric multiprocessor (SMP) system including a plurality of processors such as first processor **202** and second processor **204** connected to system bus **206**. Alternatively, a single processor system may be employed. Also connected to system bus **206** is memory controller/cache **208**, which provides an interface to local memory **209**. I/O bus bridge **210** is connected to system bus **206** and provides an interface to I/O bus **212**. Memory controller/cache **208** and I/O bus bridge **210** may be integrated as depicted. Peripheral component interconnect (PCI) bus bridge **214** connected to I/O bus **212** provides an interface to first PCI local bus **216**. Modem **218** may be connected to first PCI bus local **216**. Typical PCI bus implementations will support four PCI expansion slots or add-in connectors. Communications links to network computers **108, 110** and **112** in Figure 1 may be provided through modem **218** and network adapter **220** connected to first PCI local bus **216** through add-in boards. Additional PCI bus bridges such as second PCI bus bridge **222** and third PCI bus bridge **224** provide interfaces for additional PCI local buses such as second PCI local bus **226** and third PCI local bus **228,** from which additional modems or network adapters may be supported. In this manner, server **200** allows connections to multiple network computers. A memory-mapped graphics adapter **230** and hard disk **232** may also be connected to I/O bus **212**

as depicted, either directly or indirectly. Those of ordinary skill in the art will appreciate that the hardware depicted in Figure 2 may vary. For example, other peripheral devices, such as an optical disk drive and the like also may be used in addition or in place of the hardware depicted. The depicted example is not meant to imply architectural limitations with respect to the present invention. The data processing system depicted in Figure 2 may be, for example, an IBM RISC/System 6000 system, a product of International Business Machines Corporation in Armonk, New York, running the Advanced Interactive Executive (AIX) operating system.

With reference now to Figure 3, a block diagram illustrates a data processing system in which the invention may be implemented. Data processing system **300** is an example of either a stand-alone computer, if not connected to distributed data processing system **100**, or a client computer, if connected to distributed data processing system **100**. Data processing system **300** employs a peripheral component interconnect (PCI) local bus architecture. Although the depicted example employs a PCI bus, other bus architectures such as Micro Channel and ISA may be used. Processor **302** and main memory **304** are connected to PCI local bus **306** through PCI bridge **303**. PCI bridge **303** also may include an integrated memory controller and cache memory for Processor **302**. Additional connections to PCI local bus **306** may be made through direct component interconnection or through add-in boards. In the depicted example, local area network (LAN) adapter **310**, SCSI host bus adapter **312**, and expansion bus interface **314** are connected to PCI local bus **306** by direct component connection. In contrast, audio adapter **316**, graphics adapter **318**, and audio/video adapter (A/V) **319** are connected to PCI local bus **306** by add-in boards inserted into expansion slots. Expansion bus interface **314** provides a connection for a keyboard and mouse adapter **320**, modem **322**, and additional memory **324**. SCSI host bus adapter **312** provides a connection for hard disk drive **326**, tape drive **328**, and CD-ROM **330** in

the depicted example. Typical PCI local bus implementations will support three or four PCI expansion slots or add-in connectors. An operating system runs on processor **302** and is used to coordinate and provide control of various components within data processing system **300** in Figure 3. The operating system may be a commercially available operating system such as OS/2, which is available from International Business Machines Corporation. "OS/2" is a trademark of International Business Machines Corporation. An object oriented programming system, such as Java, may run in conjunction with the operating system and provides calls to the operating system from Java programs or applications executing on data processing system **300**. "Java" is a trademark of Sun Microsystems, Incorporated. Instructions for the operating system, the object-oriented operating system, and applications or programs may be located on storage devices, such as hard disk drive **326**, and they may be loaded into main memory **304** for execution by processor **302**.

Those of ordinary skill in the art will appreciate that the hardware in Figure 3 may vary depending on the implementation. Other internal hardware or peripheral devices, such as flash ROM (or equivalent nonvolatile memory) or optical disk drives and the like, may be used in addition to or in place of the hardware depicted in Figure 3. Also, the processes of the present invention may be applied to a multiprocessor data processing system. For example, data processing system **300**, if configured as a network computer, may not include SCSI host bus adapter **312**, hard disk drive **326**, tape drive **328**, and CD-ROM **330**, as noted by the box with the dotted line in Figure 3 denoting optional inclusion. In that case, the computer, to be properly called a client computer, must include some type of network communication interface, such as LAN adapter **310**, modem **322**, or the like. As another example, data processing system **300** may be a stand-alone system configured to be bootable without relying on some type of network

communication interface, whether or not data processing system **300** comprises some type of network communication interface. As a further example, data processing system **300** may be a Personal Digital Assistant (PDA) device that is configured with ROM and/or flash ROM in order to provide non-volatile memory for storing operating system files and/or user-generated data. The depicted example in Figure 3 and above-described examples are not meant to imply architectural limitations with respect to the present invention. It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in a form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media, such a floppy disc, a hard disk drive, a RAM, and CD-ROMs, and transmission-type media, such as digital and analog communications links.

Figure 4A is a depiction of desktop computer **410** having a main computer **420** and a display unit **422**. Display unit **422** has display screen **424**.

Figure 4B is a depiction of laptop computer 440 having a computer section 450 and display section **452**. Display section **452** has laptop display screen **454**.

Figure 5A depicts computer screen N x M array (CSA) **510** where N is the number of horizontal screen segments and M is the number of vertical screen segments. In CSA **510**, N = 3 because there are three screen segments in horizontal direction **530** and M = 3 because there are three screen segments in vertical direction **540**. As used herein a screen segment (CS) is a segment of an image on a computer screen that has sides of equal length. Screen segments can

be "tiled" together to form a square or rectangle depending on the values assigned to N and M. As used herein "tiling" means that each segment is adjacent to each segment with which it has a common side so that there are no spaces between segments and an unbroken image can appear on the display screen. In the example of CSA **510**, where N = 3 and M = 3 there are nine screen segments identified as follows, top left CS **512**, top center CS **514**, top right CS **516**, left center CS **518**, center CS **520**, left center **522**, left bottom CS **524**, bottom center **526**, and right bottom CS **528**.

Figure 5B depicts lens N x M array (LA) **550** where N is the number of horizontal lens units and M is the number of vertical lens units. In LA **550**, N = 3 because there are three lens units in horizontal direction **580** and M = 3 because there are three lens units in vertical direction **590**. As used herein, a lens unit means a convex lens that has sides of equal length. As used herein, a lens array means a group of lens units that have been tiled together to form a square or rectangle depending on the values assigned to N and M. As used herein "tiling" means that each lens unit is adjacent to each lens unit with which is has a common side so that there are no spaces between segments and an unbroken image can be seen through the LA. In the example of LA **550**, where N = 3 and M = 3 there are nine lens units identified as follows, top LA CS **512**, top center LA **514**, top right LA **516**, left center LA **518**, center LA **520**, left center LA **522**, left bottom LA **524**, bottom center LA **526**, and right bottom LA **528**.

LA **550** is used in conjunction with CSA **510**. Figure 6 depicts a convex lens and shows the image inversion achieved by a convex lens. The object in Fig 6, when viewed through the lens is seen completely inverted. The principal axis of a double convex lens is defined as the horizontal axis of the lens across which the lens is symmetrical. Light rays incident towards either face of the lens and traveling parallel to the principal axis will converge, in case of a

double convex lens, to point known as the focal point of the lens. The focal point is denoted by the letter F in Fig. 6. Each lens has two focal points—one on each side of the lens. Every lens has two possible focal points. The image of an object when viewed through a thin double convex lens will appear inverted as shown in Figure 6. Thus, if the object was inverted originally, when viewed through the thin double convex lens, the image will appear upright. The principle depicted in Figure 6 will be employed in conjunction with CSA **510** and LA **550** to scramble the image displayed on a computer screen and then to unscramble the image when viewed through LA **550**. Scrambling is achieved by dividing a computer screen image into segments and then inverting each of the screen segments. The screen may be viewed unscrambled by viewing the screen through lens array **550**.

Figure 7 is a depiction of scrambling program (SP) **700** that operates within memory **304** of computer **300**. The scrambling program starts **(710)** and queries the user to enter values for N and M **(720)**. Next, the image that is normally displayed on the computer screen is divided into segments **(730)**. In the preferred embodiment, the segments are squares, which can be tiled together to form the image. However, those skilled in the art of computer programming will appreciate that other types of segments can be formed out of other geometric shapes such as triangles and hexagons.

The screen is divided into N x M segments **(730)**. Each of the screen segments is inverted **(740)** so that when viewed through a lens array of corresponding N x M configuration, the images will be seen in their original orientation. When lens units are tiled together in LA **550**, the unscrambled image is formed on the user's side of LA **550**. In this manner, only the user who wears the glasses is able to view a comprehendible image of the computer screen. To all other users, the computer screen appears to be a garbled compilation of individual images.

In the preferred embodiment, inversion of screen segments is used. Additional methods of scrambling that may be used are reflection (making the segment image appear backwards), shrinking (making the image appear smaller than its normal size), and rotation (rotating the image about a central point). Those skilled in the arts of computer programming and optics will be aware of the various methods in which a computer screen image can be distorted so that a specific optical lens array can correct the distortion. The arrangement of the distorted segments is such that the compilation of the individual distorted segments is sufficiently different from the original image and prevents unauthorized users from comprehending the image. A determination is made as to whether the user wants to unscramble the image (**750**). If the user chooses to unscramble the image, then each N X M screen segment is returned to its original orientation and the unscrambled image will be visible on the computer display screen. If the user does not want to unscramble the image, or after the screen segments have been returned to their original orientation, a determination is made as to whether the scrambler is to be turned off (**770**). If the user does not want to turn the scrambler off, then a determination is made whether the user wants to enter new values for N and M to change the configuration of screen segments (**780**). If the user does not want to enter new values for N and M, then the scrambling program will go to step **750**. If the user does want to enter new values for N and M, then the scrambling program will go to step **720**. If the user wants to turn the scrambler off, the program will stop (**790**)

Lenses **515** consist of smaller optical lenses **525** that correspond to the segments identified in step **410** of CSS program **400**. Smaller lenses **525** optically alter the image scrambled by the corresponding segment on computer screen **510**. The tiling of lens units within lens array **550** creates a very high number of possible scrambling combinations. The possible

combinations are so numerous that it is unlikely that an unauthorized individual will have the exact same pair of glasses as the authorized user.

Figure 8 depicts augmented scrambling program (ASP) **800** having three additional security features: a password, a code word, and display glasses. As used herein, the term password means any combination of characters used to access the ASP 800. As used herein, the term codeword means any combination of characters, other than the combination of characters in the password, used to identify a particular set of values for N and M. As used herein, the term display glasses means a set of glasses that displays the computer screen image transmitted by cable or wireless technology from a computer, containing a personal display computer to unscramble a transmitted computer screen image, and so constructed that only the person wearing the glasses can see the transmitted computer screen image. Display glasses are discussed further in Figures 8B and 8C.The ASP **800** begins (**802**). A determination is made whether a correct password has been entered (**804**). If a correct password has not been entered, then the augmented scrambling program displays an error message (**806**) and returns to step **804**. If a correct password has been entered, the scrambler program is activated (**808**). Next, a determination is made as to whether a code word has been entered. If a code word is entered, then the program sets N and M corresponding to the values for that particular codeword (**812**). If a code word has not been entered, then the scrambling program queries the user to enter N and M. A determination is made whether display glasses are connected. If display glasses are connected, the computer screen image is transmitted to the display glasses (**818**) and ASP **800** proceeds to step **820**. If the display glasses are not connected, then ASP **800** proceeds to divide the screen segments into N X M segments and each screen segment is inverted (**820**). As will be further discussed below, when using display glasses for viewing the screen segments, a greater

variety of scrambling techniques can be used. In the preferred embodiment, inversion of screen segments is used. As noted with SP 700, additional methods of scrambling that may be used are reflection (making the segment image appear backwards), shrinking (making the image appear smaller than its normal size), and rotation (rotating the image about a central point). However, when using display glasses, the method of scrambling is only limited by the operations performed on each of the N X M screen segments. A determination is made as to whether a new code word has been entered (**822**). If a new code word has been entered, then the scrambling program goes to step **812**. If a new code word has not been entered, then a determination is made as to whether the scrambler has been turned off (**824**). If the scrambler has not been turned off, then the program continues and returns to step **824**. If the scrambler has been turned off, then each N X M segment is returned to its original orientation (**826**) and the scrambling program stops (**830**).

Figure 8B depicts display glasses **840** having frame **842**, top **844**, personal display screen **850**, personal display computer **848**. Personal display screen **850** has inside surface **854** and outside surface **852**. Outside surface **852** is opaque. Top **844** keeps light from interfering with viewing of images on inside surface **854**. In the preferred embodiment, inside surface **854** is a liquid crystal display (LCD). However, inside surface **854** is not limited to an LCD display and inside surface **842** may use any suitable type of display technology known to persons skilled in the art. Frame **842** secures display glasses **840** to the head of the user. Personal display screen **846** has personal display computer **870** embedded so that personal display screen **846** and personal display computer are of unitary external construction. In an alternate embodiment, personal display computer may be externally attached to either top **844**, frame **842** or personal display screen **850** and electrically connected to personal display screen **850**. Connecting cable

860 has display glasses connector **862** connected to computer connector **864** by cable **866**. Frame **842** has connecting port **846** for receiving display glasses connector **862**. Computer connector **864** may be any suitable connector known to a person skilled in the art. Display glasses **840** may be connected to a computer by either connecting cable **860** or by a wireless connection such as bluetooth technology.

Figure 8C depicts personal display computer (PDC) **870** having PDC microprocessor **872**, PDC memory **874**, PDC transmitter/receiver **876** and PDC cable connector **978**. PDC memory **874** is connected to PDC microprocessor **872** by first line **886**. PDC cable connector **878** is connected to PDC microprocessor **872** by second line **880**. PDC transmitter/receiver is connected to PDC microprocessor **872** by third line **884**. PDC microprocessor **872** is connected to personal display screen **850** by fourth line **882**. In the preferred embodiment, PDC transmitter/receiver **876** uses bluetooth technology to electronically connect display glasses **840** to a computer having either SP **700** or ASP **800** in memory. In addition, server **104** (Fig. 2), data processing system 300 (Fig. 3), desktop computer **410** (Fig. 4A) and laptop computer **440** (Fib. 4B) may all be provided with bluetooth technology or other suitable transmitting/receiving technology known to those skilled in the art for use with display glasses **840**.

Figure 9 depicts a flow chart for personal display computer program (PDCP) **900**. PDCP **900** is placed in memory **874** of PDC **870**. PDCP **900** starts when display glasses **840** are connected to an external computer, having ASP **800** in the memory of that computer, by either connecting cable **860** or transmission from the computer to PDC transmitter/receiver **876**. PDCP **900** transmits and connects with the external computer (**904**). PDCP **900** receives a transmission from the external computer containing an N X M array of scrambled screen segments (**906**). PDCP **900** determines whether a code word is contained in the transmission (**908**). If a code

word is not contained in the transmission, then PDCP **900** accesses the N x M default parameters in PDC memory **874**. If a code word is contained in the transmission, then PDCP accesses the N X M parameters stored in PDC memory **874** for that codeword. PDCP **900** then restores the scrambled images for the N x M array of image segments to their original configuration (**914**) so that the viewer using personal display glasses **840** will view the image in its unscrambled form. PDCP **900** determines whether a new code word has been received (**916**). If a new codeword has been received, then PDCP **900** goes to step **912**. If a new codeword has not been received, then PDCP **900** determines whether the transmission is over (**918**). If the transmission is not over, then PDCP goes to step **916**. If the transmission is over, then PDCP ends (**920**).

It will be understood from the foregoing that various modifications and changes may be made in the preferred embodiment of the present invention by those skilled in the art without departing from its true spirit. It is intended that this description is for purposes of illustration only and should not be construed in a limiting sense. The scope of the invention should be limited only by the language of the following claims.